Tetrahedron Letters Vol. 21, pp 3771 - 3774 ©Pergamon Press Ltd. 1980. Printed in Great Britain

EXTENSION OF THE RING OXYGEN HELICITY RULE TO THE PHENYL-AND PHENYL-1-THIO-GLYCOSIDES.

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Circular Dichroism (CD) of the phenyl- and phenyl-1-thio- $\beta(\operatorname{or} \alpha)$ -D-glycosides were studied. The sign and the rotational strength of Band C, the shortest and the strongest band between 180~210 nm, were associated with the anomeric configuration and conformation in the same manner as the  $\sigma \rightarrow \sigma^*$  band of the ring oxygen in the 1-alkyl- and 1-alkyl-thio-glycosides. This result suggested that the <u>ring oxygen helicity rule</u> could be extended to the phenyl- and phenyl-1-thio-glycosides.

Previously Meguro and Ohtaki proposed the ring oxygen helicity rule (Fig.)<sup>1)</sup> and the glycosidic heteroatom helicity rule<sup>2)</sup> as an extension of the isorotation rule by Hudson.<sup>3)</sup> The former was successfully applied to the alkyl- and alkyl-thio-glycosides. There the  $\sigma \rightarrow \sigma^*$  band of the ring heteroatom (Band C)<sup>4)</sup> might be the main CD band in governing the optical rotation at 589 nm, and the sign and the rotational strength could be deduced from the anomeric configuration and conformation. This rule can be used for the anomeric configurational and conformation. This rule can be used for the anomeric configurational and the rotation of the glycosidic sulfur of the alkyl-1-thio-glycosides can be determined by the relative geometry of the two adjacent chromophores, one is ring oxygen and the other is -OH group at C-2. This rule can be used for the configurational analysis at C-2.

Hudson's isorotation rule, which has been useful in the alkyl-glycosides, is known to have some exceptions in aromatic glycosides. In the aromatic glycosides the CD maxima at 200 ~ 300 nm have been extensively studied and the signs seemed to be associated with the anomeric configurations and syn or anti conformations.<sup>5)</sup> However they also have some exceptions and their rotational strengths seem to be not so large to govern all the optical rotations. In this study the band at the shorter wavelength region  $(180 \sim 210 \text{ nm})$  (Eand C) was discussed in the phenyl-l-thio- $(\alpha)$ -D-glycopyranosides  $(I) \sim (VII)^{7)}$  and the phenyl- $\rho(\alpha \alpha)$ -Dglycopyranosides  $(VIII) \sim (XI)^{6)}$  The model compounds are designed to have all the possible relative geometries between the glycosidic chromophore  $(-S - \bigcirc)$  and the two adjacent chromophores (-OH at C-2 and ring -O-) (Fig.). The signs and [ $\Theta$ ] of Bands (named A, B and C according to the order of the wavelengths) are shown in Table together with their UV data. The thiophenyl-glycosides  $(I) \sim (VII)$  gave the CD maxima at 278~282 nm and phenyl-



glycosides (VIII)  $\sim$  (XI) gave a series of small CD maxima at 260, 270 and 274 nm (Band A). Band A were regarded as the peaks due to the  $\alpha$  bands or  $n + \pi^*$  transitions of the thiophenyl- and O-phenyl chromophores (-O- $\langle \ddots \rangle$ ). In the phenyl-glycosides (VIII)  $\sim$  (XI) the maxima of Band A coincided with those of a series of small UV maxima at around 267 nm.

Similarly thiophenyl-glycosides (I) ~ (VII) and phenyl-glycosides (VIII) ~ (XI) gave medium CD maxima at 244~249 nm and at 216 nm respectively (Band B). These bands were regarded as the p bands of  $-S-\sqrt{2}$  and  $-O-\sqrt{2}$ . The maximal wavelengths of Band B coincided with those of UV maxima at 244~249 nm in the thiophenyl-glycosides and at 210~211 nm in the phenyl-glycosides.

The thiophenyl-glycosides (I)  $\sim$ (VII) and the phenyl-glycosides (VIII)  $\sim$ (XI) gave very large CD maxima at 198~208 rm and at 180 nm respectively (Band C). In the phenyl-glycosides Band C were calculated from ORD in the same method as the previous report<sup>4</sup> which gave the CD maxima at 180 nm. It should be added that Band C in the thiophenyl-glycosides were first directly measured using the accumulation technique on a CD apparatus and  $[\Theta_{\rm B}]$  and the CD maxima were well accorded with the values calculated from ORD. It shows that the calculations are valid in the thiophenyl-glycosides and probably they should be valid in the phenyl-glycosides.

The relations between CD bands and the structures are summarized as follows. I. (1) Band A gave the smallest peaks and the signs were associated with the anomeric configurations. Thus  $\alpha$  anomers gave positive signs and  $\rho$  anomers gave negative signs.  $[\Theta_A]$ values were almost same in  $\alpha$  and  $\rho$  anomers of glucoside, galactoside and mannoside.

	Anom.	Band A			Band B			Band C			vu		
Comp.	Con-	$\lambda_{\rm max}$	Sign	[0 <sub>A</sub> ]	$\lambda_{\rm max}$	Sign	[ <del>O</del> B]	$\lambda_{\rm max}$	Sign	[e <sup>C</sup> ]	λ <sub>max</sub>	(ε)	[e <sub>C</sub> ]∕[⋈] <sup>D</sup>
	fig.	(nm)		x 10 <sup>-3</sup>	(nm)	Ì	x 10 <sup>-3</sup>	(nm)		x 10 <sup>-3</sup>	(nm)	x 10 <sup>-3</sup>	× 10 <sup>-3</sup>
I	α	280	+	2.31	245	-	1.73	198	+	90.0	249	6.97	0.30
II	α	278	+	1.71	244		4.03	199	+	89.2	247	6.62	0.35
III	α	281	+	2.11	245		0.42	199	+	111	248	7.62	0.30
IV	ę	282		1.76	248	÷	8.33	208.5	-	24.1	248.5	7.28	0.38
v	ę	278.5	_	1.89	246	+	7.54	208.5	_	60.2	247.5	7.79	0.57
VI	ą	281	_	1.76	249	+	7.19	208	-	25.5	249	7.02	1.09
VII	Ŗ	282	-	1.63	248	÷	6,52	208		21.9	249	6.67	0,28
VIII	α	274 267 260	+ + +	1.76 2,08 1.49	216	+	14.1	180	+	75.5	267 216 <sup>s</sup> 210	0.94 7.22	0.42
XI	α	274 267 260	+ + +	1.81 2,44 1,54	216	+	15.2	180	+	81,8	267 216.5 211	,s <sup>0.97</sup> 7.13	0.39
x	₿	274 267 261	-	2.07 2.43 1.62	216	-	9.51	180	_	18.1	267 216 <sup>5</sup> 211	0.97 6.97	0.29
XI	Ŗ	274 267 260	-	2.24 2.83 1.92	216	-	10.6	180	_	11.7	267 217 <sup>5</sup> 211	0.88 6.40	0.27

Table Chiroptical data of phenyl-1-thio-  $\mathfrak{g}(\operatorname{or} \alpha)$ -D-glycopyranosides (I) ~ (VII) and phenyl- $\mathfrak{g}(\operatorname{or} \alpha)$ -D-glycopyranosides (VIII) ~ (IX).

Solvent : Ethanol. CD measurements : On a DICHROGRAPH Mark III-J, 1 mm cell, about 0.3 mg/ml. UV measurement : On a HITACHI Model 200-100 Spectrophotometer, 1 cm cell, about 6.0 x  $10^{-3}$  mg/ml. [M]<sub>D</sub> measurement : On a Jasco ORD/UV-5, 1 cm cell, about 3.0 mg/ml. s: shoulder.

(2) Band B gave medium peaks. In the thiophenyl-glycosides  $\alpha$  anomers gave negative signs and  $\emptyset$  anomers gave positive signs. On the contrary  $\alpha$  anomers gave positive signs and  $\emptyset$  anomers gave negative signs in the phenyl-glycosides. The signs and  $\{\Theta_B\}$  of Band B seem to be difficult to be associated with the configurations and conformations at C-1 and C-2. It shows that <u>the</u> glycosidic heteroatom helicity rule could not be extended to the phenyl- and thiophenylglycosides.

- II. In Band C the results are summarized as follows.
  - (1) Band C were the strongest bands in the three bands.
  - (2) The observed  $[\Theta_{C}]$  were almost identical with the calcd. values from ORD.
  - (3) The signs were associated with the anomeric configurations ( $\alpha$ -positive,  $\beta$ -negative).

(4)  $[\Theta_{C}]$  of  $\alpha$  anomers (axial config.) were about  $1.5 \approx 7$  times as large as those of  $\varphi$  anomers (equatorial config.).

(5) The ratio of  $[\theta_C]/[M]_D$  were  $0.27 \sim 0.57 \times 10^3$  (except for compound (VI)). They were almost in the same orders as those of the alkyl- and alkyl-thio-glycosides<sup>1</sup>. The large deviation in the compounds (V) and (VI) might be the effects of Band A and Band B.

The above results well accorded with those of Band C (160~180 nm),  $d \rightarrow d^*$  bands of the ring oxygens, in alkyl- or alkyl-thio-glycosides<sup>1</sup>. It strongly suggests that Band C at 198~ 208 nm in thiophenyl-glycosides and at 180 nm in phenyl-glycosides might be the bands of the same origin. The redshift could be explained by the effect of the anomeric phenyl- or thiophenyl-groups. Under the above assumption the ring oxygen helicity rule is suggested to be extended to the phenyl-and phenyl-l-thio-glycosides or probably to the other aromatic glycosides.

## References and Notes

- E.Ohtaki, H.Meguro and K.Tuzimura, Tetrahedron Lett., <u>49</u>, 4339(1977)
  H.Meguro, E.Ohtaki and K.Tuzimura, ibid., <u>36</u>, 3371(1978)
- 2) E.Ohataki, H.Mequro, ibid., 35, 3297(1979)
- 3) C.S.Hudson, J.Amer.Chem.Soc., <u>52</u>, 1680,1707(1930) and previous papers.
- 4) The signs, the wavelengths and the rotational strengths (kc) of Band C were calculated using one term Drude equation based on the ORD data between 300~600 nm region according to the graphic method by Iizuka et al.<sup>8)</sup>  $[\Theta_c]$  were calculated from kc assuming that Band C were Gausian.
- Y. Tsuzuki, M.Koyama, K.Aoki, T.Kato and K.Tanaka, Bull.Chem.Soc.Japan., <u>42</u>, 1052(1969)
  Y.Tsuzuki, S.Kataoka, M.Funayama and K.Satsumabayashi, ibid., <u>44</u>, 526(1971) and their papers.
- 6) Thiophenyl-glycosides (I)~ (VII) were prepared from tetra-O-acetyl-glycosyl bromide and phenyl tributhylstannyl sulfide by the lowering the nucleophilicity of sulfur through trialkylstannylation. This reaction was catalyzed by zinc chloride.<sup>9)</sup> All compounds gave correct elementary analyses data. The ring conformations of all compounds were postulated as  ${}^{4}C_{1}$  chair forms from the PMR studies. (I): mp 154°,  $[\alpha]_{D}^{21}$  +302.8°, (II): solid,  $[\alpha]_{D}^{21}$  +252.5°, (III): mp 131°,  $[\alpha]_{D}^{21}$  +376.6°, (IV): mp 131°,  $[\alpha]_{D}^{21}$  -63.4°, (V): mp 130°,  $[\alpha]_{D}^{21}$  -105.3°, (VI): mp 109°,  $[\alpha]_{D}^{21}$  -23.5°, (VII): mp 138°,  $[\alpha]_{D}^{21}$  -78.9°. (conc. 3mg/ml, in ethanol).
- 7) The phenyl-glycosides were commercially available.
- 8) E.Iizuka and J.T.Yang, Biochem., 3, 1519(1964)
- 9) T.Ogawa and M.Matsui, Carbohydr.Res., 54, Cl7(1977)
  - T.Ogawa and M.Matsui, Nippon Nogeikagaku Kaishi, 52, 53(1978)
- 10) The study was supported by the grant from the ministry of education of Japan.

(Received in Japan 18 June 1980)